

Packaged CHP Accelerator  
Topical Webinar – REopt Lite  
February 18, 2020

# Agenda

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- REopt Lite
  - Kate Anderson, NREL
  - William Becker, NREL
  - Dan Olis, NREL
- eCatalog Update
  - Rich Sweetser
- Packaged CHP Accelerator Update
  - Bruce Hedman
  - Trent Blomberg
  - Rick Tidball

*This Webinar Is Being Recorded*

# REopt Lite

# REopt Lite CHP Model

Kate Anderson, Dan Olis, Bill Becker  
NREL REopt Team  
February 18, 2021  
[reopt.nrel.gov](https://reopt.nrel.gov)

# Agenda

**1:00-1:30**      **Overview of New CHP Capabilities**

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**1:30-2:00**      **Tool Demo**

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**2:00-2:30**      **Questions & Answers**

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# Project Goals and Timeline

- Goals and motivation for tool
  - Funded by U.S. Department of Energy Advanced Manufacturing Office and Federal Energy Management Program
  - Provide a free tool for facility owners and industry to evaluate CHP with PV, wind, and/or storage (hybrid CHP)
  - Inform economic and resilience investment decisions
- Timeline
  - February 2021: Beta release
  - September 2021: Final release





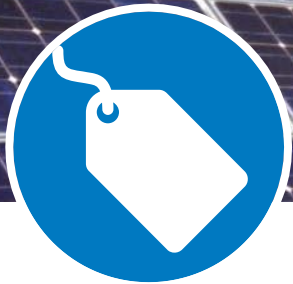
## REopt Lite Web Tool Transforms Complex Decisions Into Actionable Results

- The free, publicly available web tool guides investment in economic, resilient energy technologies
- Transforms complex decisions into actionable results for building owners, utilities, and industry
- Integrating CHP enables analysis of hybrid CHP (CHP + PV, wind, and/or storage)
- Open Source API access to the tool enables analysis at scale

# Will Hybrid CHP Work for Your Site?



**RE  
Resource**



**Technology Costs  
& Incentives**



**Resilience  
Goals**



**Utility Cost &  
Consumption**



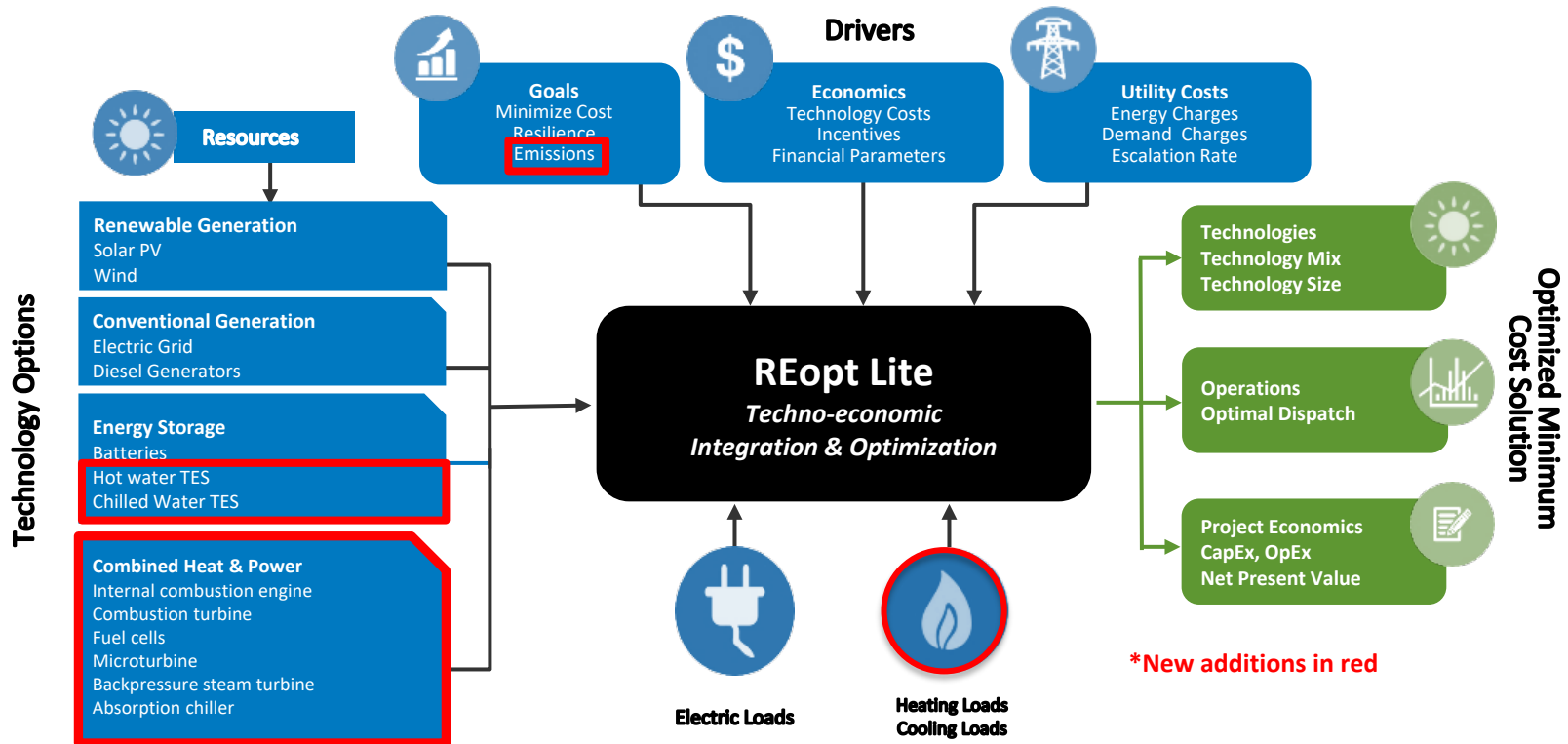
**Financial  
Parameters**

*Many factors affect whether distributed energy technologies can provide cost savings and resilience to your site, and they must be evaluated concurrently.*



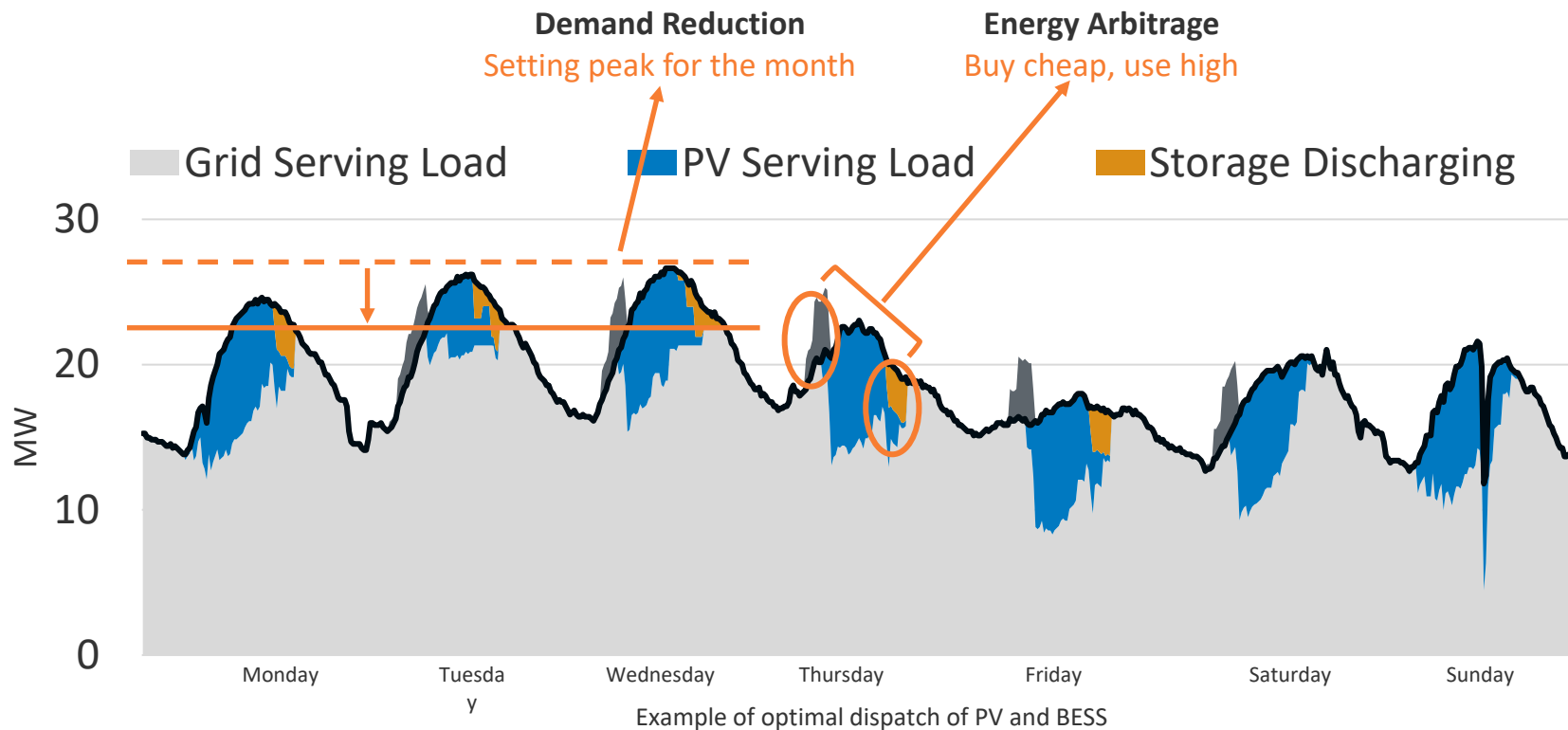
# REopt Lite: Free Web Tool to Optimize Economic and Resilience Benefits of DERs

*Formulated as a mixed integer linear program, REopt Lite provides an integrated cost-optimal energy solution.*



# How Does REopt Lite Work?

*REopt Lite considers the trade-off between ownership costs and savings across multiple value streams to recommend optimal size and dispatch*



# REopt Lite User Interface

- **REopt Lite** is a web tool that offers a no-cost subset of NREL's more comprehensive REopt model
- **Financial mode** optimizes technology sizes and dispatch strategy to minimize life cycle cost of energy
- **Resilience mode** optimizes technology mix to sustain critical load during grid outages and to minimize life cycle cost of energy
- To access REopt Lite:  
<https://reopt.nrel.gov/tool>

## Step 1: Choose Your Focus

Do you want to optimize for financial savings or energy resilience?

☒ Financial

☐ Resilience



## Step 2: Select Your Technologies

Which technologies do you wish to evaluate?

☒ PV

☒ Battery

☐ Wind

☒ CHP

☐ Chilled Water Storage

Existing boiler type and assumed CHP thermal production type

Hot water

Select additional CHP technologies to evaluate

☐ Hot Water Storage

☐ Absorption Chiller

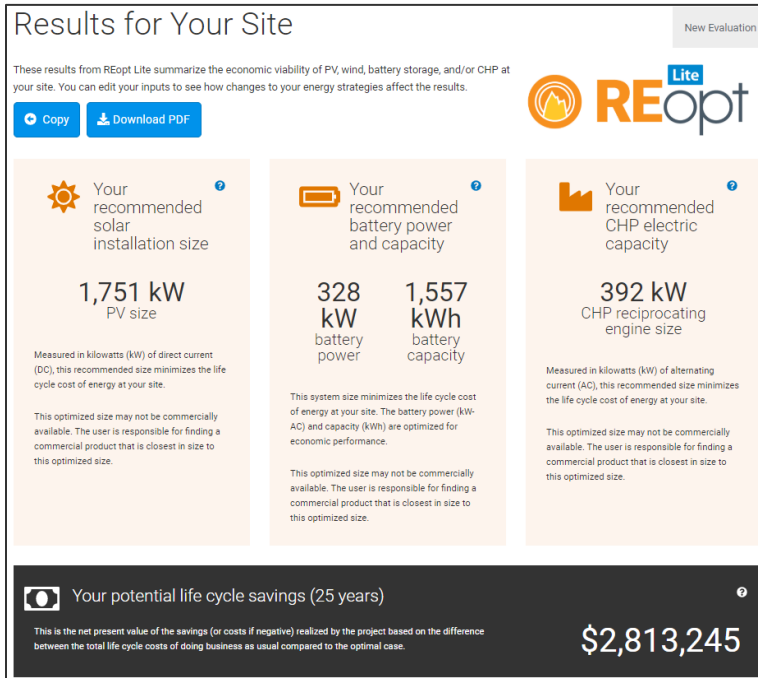
## Step 3: Enter Your Site Data

Enter information about your site and adjust the default values as needed to see your results.

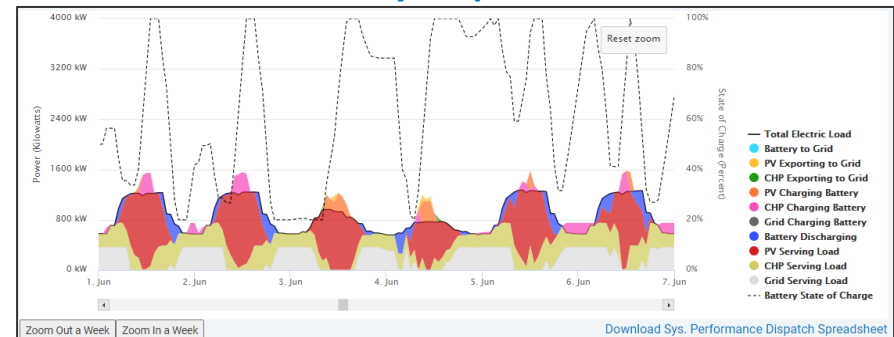
📍 Site and Utility (required)	+
📶 Load Profile (required)	+
💰 Financial	+
🔥 Emissions	+
⚙️ PV	+
🔋 Battery	+
🏠 Combined Heat & Power	+

# REopt Lite Key Outputs

## System Size and Net Present Value



## Hourly Dispatch



## Detailed Financial and Energy Outputs

Summary Financial Metrics			
Total Upfront Capital Cost Before Incentives	N/A	\$4,828,681	N/A
Total Upfront Capital Cost After Incentives	N/A	\$3,070,132	\$3,070,132
Lifecycle O&M and replacement costs, after tax	N/A	\$1,399,584	\$1,399,584
Total Life Cycle Costs	\$15,056,424	\$12,243,179	\$2,813,245
Net Present Value	\$0	\$2,813,245	\$2,813,245
Payback Period	N/A	5.56 yrs	5.56 yrs
PV Levelized Cost of Energy	N/A	\$0.074	\$0.074
Internal Rate of Return	N/A	16.23%	16.23%

# CHP and Related Technologies in REopt Lite

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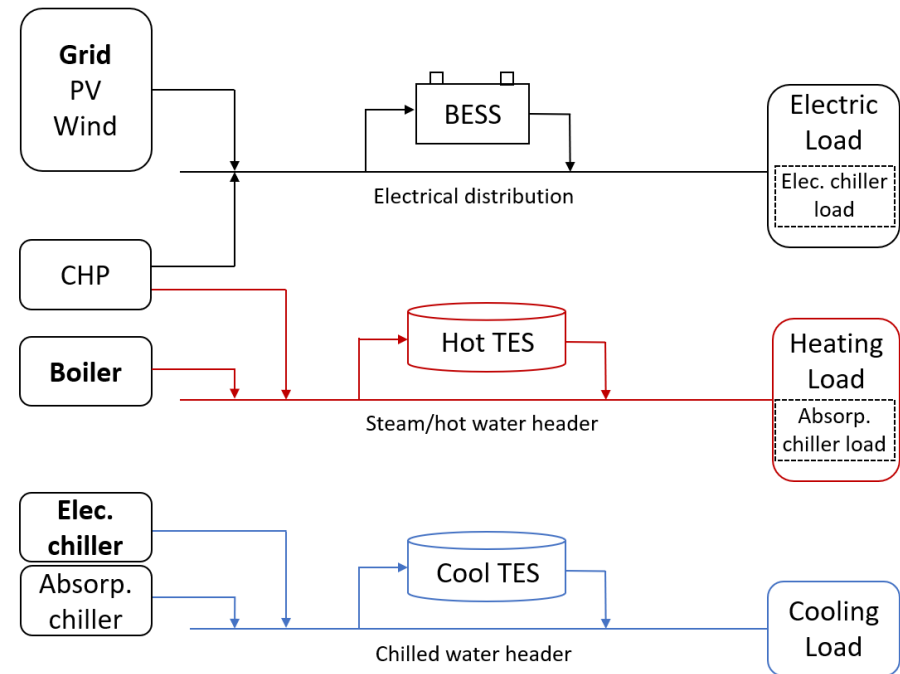


# Scope

1. CHP and Hybrid CHP
2. Screening for technical and economic potential; not a design tool, i.e., does not replace consultation with technical experts and application engineers
3. Retrofit application
4. Defaults based on commercial to small industrial scale
5. Technology sizes are typically an output although the user can fix sizes

# Assumptions

- Existing conditions:
  - Electrical service from a utility
  - Service from natural gas pipeline or fuel storage and delivery infrastructure
  - Central heating plant
  - Central cooling plant if absorption chillers and chilled water TES are analyzed
- CHP system can operate in parallel with electric utility and centralized heating and cooling plants
- CHP can serve some, all, or none of the electric and heating loads
- No equipment redundancy requirements and factors of safety
- User-entered loads and available renewable resources do not change significantly over the analysis period
- There is space at the facility to install equipment



# Prime Mover Defaults

- Defaults provided for:
  - Reciprocating engine
  - Microturbine
  - Combustion turbine
  - Fuel cell
- Primarily from DOE Fact Sheets except part load conditions
- ISO-like conditions, natural gas
- Prime mover model includes part-load impacts on fuel efficiency and heat recovery
- Specific heat recovery configurations and process fluid conditions (linked to the heat recovery)
  - 160 F inlet / 180 F exit water, or
  - 150 PSIG saturated steam

Prime Mover	Reciprocating Engine					
Class size low (kW)	30	30	100	630	1,140	3,300
Class size high (kW)	9,300	100	630	1,140	3,300	10,000
Minimum electric power capacity (kW)	0	0	0	0	0	0
Minimum non-zero power capacity (kW)	15	15	50	315	570	1,650
Maximum electric power capacity (kW)	10,000	10,000	10,000	10,000	10,000	10,000
Installed cost function, installed cost (\$/kW), and size pair at lower size	\$3,300, 30 kW	\$3,300, 30 kW	\$2,900, 100 kW	\$2,700, 630 kW	\$2,370, 1,140 kW	\$1,800, 3,300 kW
Installed cost function, installed cost (\$/kW), and size pair at larger size	\$1,430 9,300 kW	\$2,900, 100 kW	\$2,700, 630 kW	\$2,370, 1,140 kW	\$1,800 3,300 kW	\$1,430 9,300 kW
Fixed O&M (\$/kW/yr)	0	0	0	0	0	0
Variable O&M cost (\$/kWh)	0.019	0.0245	0.0225	0.020	0.0175	0.0125
Electric efficiency at 100% load (HHV basis)	35.6%	29.6%	32.1%	35.8%	39.0%	41.5%
Hot water thermal efficiency at 100% load (HHV basis)	43.6%	50.3%	47.9%	43.6%	40.5%	36.8%
Steam thermal efficiency at 100% load (HHV basis)	14.8%	0.0%	18.2%	16.9%	14.4%	12.8%
Cooling thermal factor (single effect)	0.83	0.80	0.83	0.85	0.85	0.85
Min. electric loading of prime mover (% of rated electric capacity)	50%	50%	50%	50%	50%	50%

# Live Demo of REopt Lite

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# REopt Lite CHP Development Team

## **NREL**

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- Bill Becker
- Gregg Tomberlin
- Dylan Cutler
- Alex Zolan
- Nick Laws
- Ted Kwasnik
- Linda Parkhill
- Andrew Jeffery
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- Kathleen Krah
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# Thank you!



REopt Lite (tool and help manual): [reopt.nrel.gov/tool](https://reopt.nrel.gov/tool)

REopt Website (analysis services and case studies): [reopt.nrel.gov/](https://reopt.nrel.gov/)

Send tool feedback and ask a question: [reopt@nrel.gov](mailto:reopt@nrel.gov)

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**[www.nrel.gov](https://www.nrel.gov)**

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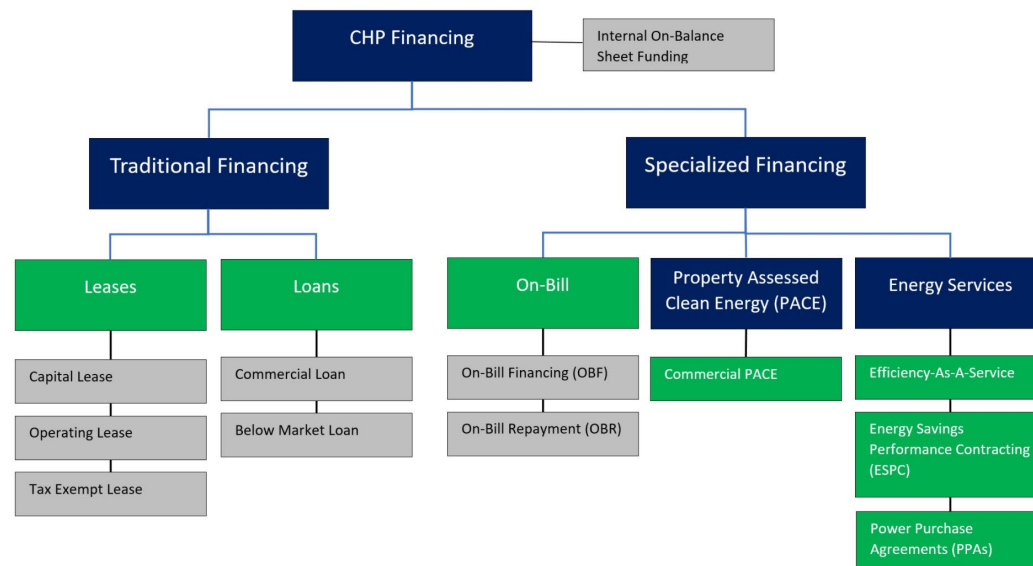
# eCatalog Update

# January 7, 2021 Accelerator eCatalog Review

The following changes (in green) have been made as a result of your input from the January 7 Partner Meeting:

- Improve page navigation so users don't need to scroll through all info if they're looking for something specific. Also, increase engagement with user-interactive graphics that deliver some of the info in the text.

Revised Benefits and Financing pages accordingly and added new Resource Page. Below is an example of the interactive financing map.



# Detailed Input

- There should be a FAQ section addressing common objectives  
Page has been started and is found under “Resources – FAQ”.
- Additional news and events outlets for DOE to monitor  
Added suggested outlets and now currently have CHP news articles and events from 45 different sources.
- Additional resources useful to post in the news & events feed  
Added New CHP Projects, New CHP Programs, and New Technologies as new categories for Packagers, Solution Providers and Customer Engagement Partners to submit directly to the eCatalog for review and posting.
- Filter Packagers, Solution Providers and Customer Engagement Partners by geographic location and coverage  
Filter by state using a dropdown list. Soon to have interactive map to filter.
- Made in USA should comply with FTC requirements  
eCatalog Packaged in the USA designation was not a well defined metric.  
Currently removed from the eCatalog.

# Detailed Input (continued)

- More information on C-PACE  
Now have interactive link on the Financing page to DOE C-PACE webpage. More updates to come.
- More visual emphasis on describing what Packagers and Solution Providers are:  
To be completed.
- Add waste heat to power (WHP) applications  
Working on steam turbine generators and ORC standalone packages to the eCatalog later this year.
- If possible, add Trade Allies by region/market  
Developing Trade Ally lists. Need access to Engagement Partner lists and contact information, if possible.

**Please review all new pages and features. Send us any new ideas, suggestions, or comments.**

Now, let's go





# Packaged CHP Accelerator Update

# CHP Trade Allies – Google Questionnaire

- Does your organization maintain a list of CHP trade allies?
- If so, what types of trade allies are included?
  - Consulting engineers
  - CHP consultants (screenings, audits, assessments)
  - Service and maintenance
  - Start-up/Commissioning
- Are there specific criteria or requirements to be on the list? If so, please describe
- Can we contact them for inclusion in the eCatalog?

### CHP Trade Allies

Briefly provide information on your network of combined heat and power trade allies.

\* Required

Name \*

Your answer

Company / Organization \*

Your answer

Email Address \*

Your answer

Does your company/organization maintain a list of CHP trade allies? \*

☐ Yes

☐ No

If so, what types of trade allies are included in the list?

☐ Consulting Engineers

☐ CHP Consultants (provide screenings, energy audits, and facility assessments)

☐ Service & Maintenance Companies

☐ Start-Up/Commissioning Agents

☐ Other:

Do you have specific criteria or an outlined process for organizations to be listed as a trade ally? \*

☐ Yes

☐ No

If so, please briefly outline that criteria or process for trade allies.

Your answer


# Topical Webinar Series - 2021

- February 18 - REopt Lite
- March 25 – Microgrid Database
- April/May – Renewable Natural Gas
- June - Market Sector Deep Dive - Healthcare



# Market Sector Fact Sheets


- Brief summaries of key CHP market sectors
- Actionable information on CHP benefits, addressable loads, site requirements, typical systems and brief case studies
- Account reps, end users, and design community
- On deck:
  - Greenhouses
  - Wastewater treatment facilities
  - Correctional facilities


**Better Buildings**  
U.S. DEPARTMENT OF ENERGY

**Combined Heat and Power Fact Sheet Series**  
**CHP MARKET SECTOR: HOSPITALS**

### CHP at Hospitals

Hospitals and healthcare systems are at the front line of responding to natural disasters, reducing mortality rates, and assisting with public health crises. It is imperative that these facilities, along with the patient health and critical life support systems they house, operate nonstop. Yet economic development continues to grow in regions that face extreme weather events—events whose intensity, duration, and geographic reach are on the rise. The trend affects even areas of the country not historically associated with severe weather. Furthermore, most communities are struggling with weak or outdated infrastructure. In the face of these natural hazards, healthcare organizations must improve the resilience of their facilities, including power delivery systems. One approach is the installation of combined heat and power (CHP) systems. Well suited to meet both resilience requirements and energy demands, CHP can provide electricity, hot water, and space heating and cooling during both normal operations and major outage events.



Doctors Community Hospital in Lanham, Maryland, installed two 600 kW reciprocating engines to provide 80% of the hospital's electrical load and 90% of the hospital's thermal load. Photo courtesy of Doctors Community Hospital

### Characteristics of Energy Use in Hospitals

A hospital is one of the most energy-intensive commercial building types, using more than three times the energy per square foot compared to a typical office building. Hospitals require continuous power for their operations and have significant thermal demands for heating, hot water, steam for sterilization, cooling, dehumidification, and laundry services. These coincident thermal and electric loads make CHP a good fit to provide year-round critical power and thermal energy. Figure 1 (next page) shows average monthly hospital electric and gas loads, modeled using DOE Commercial Reference Buildings for two different weather regions.<sup>2</sup> Electric and gas loads are relatively consistent for facilities in both warm and cold climates, with some fluctuation due to space heating in winter and space cooling in summer. CHP can meet baseload thermal demand year-round and can provide cooling in warmer months, which could significantly decrease electricity costs and generate resilient space cooling on site.

### HOSPITAL CHP QUICK FACTS

- Hospitals have **24-7 energy loads** and significant thermal requirements (hot water, space heating/cooling).
- CHP's **reliability** independent of the electric grid makes it a good match for hospital needs as **critical infrastructure** in the event of disasters.
- Over a quarter of all existing CHP systems at hospitals were installed after 2012.
- Hospitals spend an average of **\$3.16 per square foot** on energy costs each year. CHP can help reduce these costs and free up resources for patient care.<sup>1</sup>
- The current average CHP installation size at a U.S. hospital is **~3.3 MW**.


### Packaged CHP Systems «Catalog

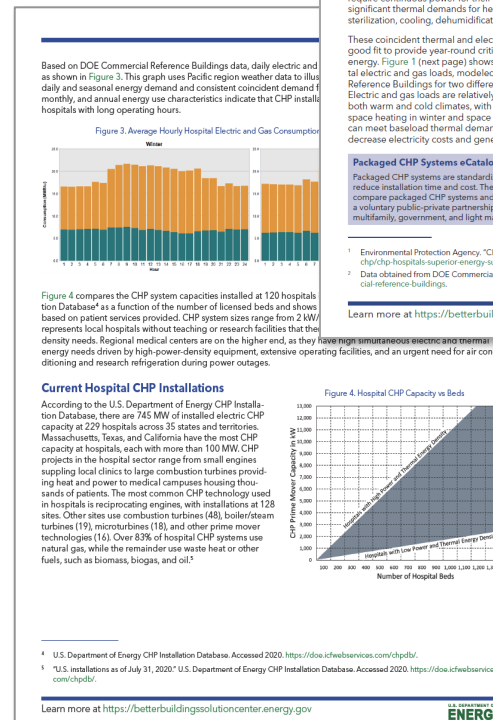
Packaged CHP systems are standardized, prefabricated CHP systems built off site prior to installation, allowing customers to reduce installation time and cost. The Packaged CHP «Catalog from DOE provides tools for users to learn about, select, and compare packaged CHP systems and solutions that have been reviewed and recognized by DOE. The «Catalog is the product of a voluntary public-private partnership designed to validate packaged CHP technologies for growing commercial, institutional, multifamily, government, and light manufacturing markets. Visit the DOE CHP «Catalog at <https://chp.catalog360.gov/>.

<sup>1</sup> Environmental Protection Agency, "CHP for Hospitals: Superior Energy for Superior Patient Care." Accessed 2020. <https://www.epa.gov/chp/chp-hospitals-superior-energy-superior-patient-care>.

<sup>2</sup> Data obtained from DOE Commercial Reference Buildings, modeled in EnergyPlus. <https://www.energy.gov/eere/buildings/commercial-reference-buildings>.

Learn more at <https://betterbuildingsolutioncenter.energy.gov>





# CHP Engagement Partners – Next Steps

- Enroll as a Customer Engagement Partner in the eCatalog
  - Company and CHP program description
  - Service area (zip code)
  - Logo
- Complete Engagement Partner Roadmaps
  - Accelerator deliverable item
  - Develop with Accelerator team support
    - Trent Blomberg and Rick Tidball
  - CHP program objectives, priorities, and plans

### Customer Engagement Partners

CHP Engagement Partners (utilities, federal agencies, states, and municipalities) commit to promote Packaged CHP Systems (via the eCatalog) to their customers, constituents, or members and to validate the performance and the benefits of packaged CHP. Customer Engagement Programs can range from education and outreach on the benefits and applicability of CHP to technical assistance in evaluating and implementing CHP to incentives or other financial support depending on the objectives and resources of individual Customer Engagement Partners.

FILTER BY STATE:

**4 RECOGNIZED STATE-LEVEL CUSTOMER ENGAGEMENT PARTNERS**

**7 RECOGNIZED UTILITY-LEVEL CUSTOMER ENGAGEMENT PARTNERS**

### Customer Engagement Partners

PROMOTE YOUR CHP PROGRAM

NOTE: To complete the eCatalog, you must first enroll as a CHP Engagement Partner.

**Enrollment Requirements**

Customer Engagement Partners must be identified as a CHP Engagement Partner in the eCatalog.

### UTILITY-LEVEL CUSTOMER ENGAGEMENT PARTNER

Back to all Customer Engagement Partners

**BGE SMARTENERGY savers PROGRAM**

<b>Customer Engagement Partner</b>	Baltimore Gas & Electric
<b>Contact</b>	Brendan Cassidy
<b>Address</b>	110 W. Fayette Street Baltimore, MD 21201
<b>Phone</b>	+14102901202
<b>Email</b>	brendan.cassidy@bge.com
<b>Website</b>	<a href="https://www.bgesmartenergy.com/business/chp">https://www.bgesmartenergy.com/business/chp</a>

**Program Description**

Baltimore Gas & Electric (BGE) is Maryland's largest gas and electric utility, delivering power to more than 1.2 million electric customers and more than 655,000 natural gas customers in central Maryland. The Combined Heat and Power (CHP) program is offered as part of the utilities' EmPOWER Maryland energy efficiency programs and is an additional component of the BGE Smart Energy Savers Program®. The CHP program is intended to provide customer incentives that will make it more economically viable for Commercial and Industrial customers to employ CHP to reduce their energy (kWh) consumption and demand (kW) usage. Eligible CHP systems must be sized to meet all or a portion of the customer's on-site load, not to exceed 100% of most recent historical annual consumption or peak demand. Incentives are not available for CHP systems that serve off-site customers, exports to the grid, or are not located on the customer's property. Incentives under the program are calculated by the system capacity and three payments are comprised of a Design Incentive, Commissioning Incentive, and a Production Incentive.

Tiered Incentives: Less than or equal to 50kW - \$2,000 per kW; Between 51kW and 200kW - \$1,600 per kW; Between 201kW and 1MW - \$1,200 per kW; Greater than 1MW - \$800 per kW.

1) Design Incentive: 10% of total incentive at project approval, subsequent to signed commitment letter and acceptance of minimum requirements document.

2) Commissioning Incentive: 30% of total incentive after installation is complete, subsequent to commissioning of the CHP system and BGE inspection.

3) Production Incentive: 60% of total incentive after receiving 12 contiguous months of actual kWh generation data received within 24 months of project installation, subsequent to review of metering data. Payment will be prorated, based on actual kWh generation and will be capped at 60% of total incentive. For example, if the actual kWh generation is 80% of estimated, the Production Incentive will be decreased by 20%.

Project Caps: The maximum incentive any one CHP project could receive is \$2.5 million. A limit of one project per customer site every 3 years applies. BGE seeks to assist those customers who are interested in CHP and be able to make more informed decisions about possible participation in the CHP Program. A dedicated CHP outreach specialist is available to assist applicants through the entire process. More information is available here: <https://www.bgesmartenergy.com/business/chp>

**Technical Assistance**



# DOE Team

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<https://betterbuildingssolutioncenter.energy.gov/accelerators/packaged-chp>

<https://chp.ecatalog.lbl.gov/>